BOOKS

BY

Jesse Feiring Williams, M. D.

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A TEXT-BOOK

of

ANATOMY and PHYSIOLOGY

FOR SCHOOLS OF NURSING, NORMAL SCHOOLS, AND COLLEGES

By

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WITH 369 ILLUSTRATIONS
25 OF THEM IN COLORS

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To Workers
In the Field of the Practical Arts

Household Arts
Nursing
Occupational Therapy
Physical Education
Physiotherapy

PREFACE

THIS book presents the essentials of anatomy and physiology for students of the practical arts—nursing, physical education, physiotherapy, occupational therapy, and household arts. Since the subject matter of these sciences is well developed and generally available, the merit of a book of this kind must reside in the arrangement effected, the teaching helps used, the emphasis given, and the number and quality of illustrations selected.

Arrangement.—The subjects of anatomy and physiology when presented in abbreviated form frequently lack unity and logical sequence because of the selection of isolated facts. Consequently, it often happens that important points and fundamental concepts are omitted. In the writing of this book an effort has been made to present the basic and essential data concerning the structure and function of the human body in an orderly and logical sequence.

Moreover, the book seeks to awaken in the student an interest in the study that shall be more compelling than that of a required course. Such an aim is in harmony with the purposes of all real teachers. To this end, as well as for other practical reasons, embryology is given a distinct place in the text. Bones, muscles, nervous system, and viscera have meaning when introduced in the light of their origin and development.

The approach is the biologic one. The cell, its structure, and functions is the beginning of the study. Then follow the different systems of the body. The nervous system is considered after the muscular system and before the visceral systems because its structure and function are so fundamentally related to understanding of the viscera. It is the most difficult for students, and instructors may leave it for the latter part of the course, if they will early establish certain fundamental ideas concerning structure and function of neurons, centers, and brain areas.

Teaching Helps.—There would be little excuse for another text-book on anatomy and physiology if something worth while could not be added to make the teaching of these subjects more effective. The arrangement is important always, but the practical helps that can be given student and instructor are even more essential.

Teaching difficulties are lightened by suggestions for practical application of the theory. The sciences of anatomy and

physiology present serious difficulties because of the new vocabulary to be mastered and the great mass of new facts to be learned. The problem for the teacher of these sciences outside the medical school is primarily one of developing a field where the new words and new facts may be used, for they are worthless unless interpreted in the light of use and of meaning. Therefore at the end of each section are placed a series of practical exercises, a group of spirited questions, and a list of selected references. The references may or may not be required by the instructor, but for those students who are interested and who wish to look further into the subject a teaching help is offered. Moreover, reference is made to supply houses where slides, biologic material, charts, models, and other desirable supplies may be purchased. To help the teacher has been a constant motive in the mind of the author.

Emphasis.—The book is arranged to serve the needs of the student of anatomy and physiology outside the medical school. Whether a student of nursing, of physical education, or of one of the allied fields, their problems are fundamentally alike. For all, normal structure and function have significance in the light of the deviations from normality. The nurse and physiotherapist need this information for their hospital work; the teacher of physical education for the instruction in hygiene as well as the work in normal diagnosis.

The book covers the essentials of anatomy and physiology. There may well be disagreement with what has been included and what omitted. The author is well aware of the factor of personal equation that determines "essentials." And yet on the basis of a number of years' experience in teaching these subjects, there comes a certain justification. Moreover, the recommendations of the "Standard Curriculum for Schools of Nursing" have been followed, the needs of physiotherapy and occupational therapy aides as shown in our army hospitals have been experienced, and the problems of teachers and physical educators have been kept in mind.

The emphasis given in different chapters is based upon the effort to present the essentials of this study. The time given by the instructor to different portions of the text will vary with the teaching facilities available, other courses offered in the institution, as well as with special needs that may be felt. Thus, instructors of students of physical education may wish to give

relatively a large amount of time to the muscular system, instructors of nurses may wish to emphasize more the circulatory system, but no narrow point of view should be taken if adequate understanding of body structure and function is to be developed.

Whatever the opinion may be about the selection made of the general material, there doubtless will be instant approval of the emphasis given to the anatomy and physiology of the child. The usual texts so often treat the structure and function of the human body as if it were an automobile engine, of fixed and unvarying parts, of constant and uniform action. This is a great mistake, especially for the students of nursing and of physical education. For them, more than for any other workers in the field of the practical arts, the anatomy and physiology of the child are very important. It is greatly to be regretted that we do not have more detailed knowledge of old age.

Illustrations.—Three hundred and sixty-nine illustrations are used to make clear the text. Twenty-five of them are in color. The importance of illustrations hardly needs mention. It is sufficient to note that without adequate opportunity for dissection of the human cadaver the student is dependent very largely on illustrations for comprehension of the text.

Arrangement, teaching helps, emphasis, and illustrations—these four factors should render a distinct service. They are the source of the aim that seeks to make this book the most helpful one of its kind to students of the practical arts.

I wish to acknowledge the assistance of many friends and teachers with whom the teaching problems of anatomy and physiology have been discussed. In particular, I wish to express here my appreciation to Miss Katharine Ink, Visiting Instructor of Nurses, Presbyterian, French, and Fifth Avenue Hospitals; to Professor Isabel M. Stewart of the Department of Nursing, Teachers College; to Professor A. Elwyn of the Department of Anatomy, and to Professor R. Burton-Opitz, of the Department of Physiology of this University, for their expert help and criticism in preparation of the manuscript.

It is perhaps needless to say that this acknowledgment is in no sense a shifting of responsibility; errors where they occur are mine.

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TEACHERS COLLEGE,
COLUMBIA UNIVERSITY,
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A TEXT-BOOK OF ANATOMY AND PHYSIOLOGY

CHAPTER I

INTRODUCTION

The Study of the Human Body.—To students of human anatomy and physiology the related biologic sciences contribute valuable assistance in helping to understand the body. Embryology, zoölogy, and botany describe not only the origin and nature of plant and animal life but also from a comparative standpoint indicate the relatedness of all living matter. In a narrow sense the study of anatomy is the study of structure. Oftentimes it is quite uninteresting because the meaning of the structure is not interpreted. Contrariwise, anatomy may be most interesting, may even seem vital to the student, when studied in relation to living forms of life in general, and interpreted in practical ways affecting man. Thus, anatomy may record the fact of branchial arches in the developing embryo,*

* The term "embryo" is used while the new individual is in the early stages of development, during the first three months. "Fetus" is the term used to designate the new individual after organs and parts are well formed.

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but these structures need interpretation to have meaning and significance.*

Other sciences help to make clear the meaning of anatomic structure. Physiology attempts to describe how that structure functions, what it does under certain conditions. Pathology describes the deviations from the normal in structure, no matter how caused. Both of these sciences are dependent for an explanation of the processes of life upon the advances made and to be made in physics and chemistry, and particularly in the newer developments of physical chemistry.

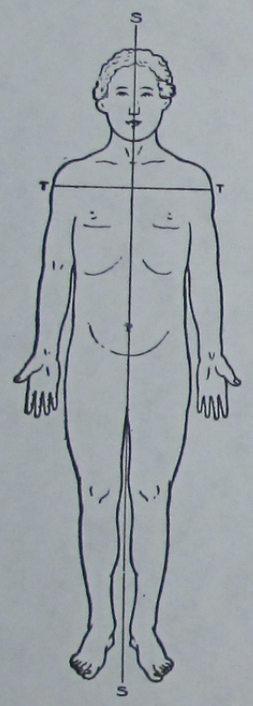

Fig. 1.—The two chief planes of the body: *T*, transverse; *S*, sagittal.

Anatomy as a study would seem quite sterile if pursued alone. What is the origin of this structure, how did it develop, what are its common variations from the normal? These are practical considerations full of meaning and significance. Hence it seems that the beginning study of the human body should include not only the anatomy of the parts but also aspects of embryology, facts of comparative development and evolution, principles of physiology, and the important functions of the body.

Terminology.—In describing the human body it is necessary to have an agreement concerning the use of terms that define positions, give directions, and explain relations. For these purposes anatomists begin with a statement of the anatomic position of the body. This is taken to be an erect position, with the arms hanging at the sides of the body and the palms turned forward. In this position several planes, surfaces, and directions are recognized. There are two chief planes of the human body: the *sagittal*, which passes vertically and divides the body into two equal and symmetric halves, and the *transverse*, which passes horizontally to the sagittal (Fig. 1). There are two surfaces: the *anterior, ventral*,* or front, which presents the body in the anatomic position toward the observer, and the *posterior, dorsal*, or back, which is the opposite surface. It will be seen that these planes and surfaces define the relationship of parts. Other terms are necessary to more specifically locate and to give direction. *Superior, inferior, upper*, and *lower* are used to designate parts toward or away from the head end of the body. Parts nearest to the sagittal plane are described as *mesial*, parts farthest from this plane are called *lateral*. The terms *internal* and *external* are used to define within or without relationships of the body or its parts. The *midsternal line* coincides with the sagittal. It is used to locate heart and lung borders to the left and right of it. *Proximal* and *distal*, *central* and *peripheral* are terms used to designate nearness to source or beginning of part, or the opposite. *Homologue* is a term indicating identical structural characteristics of common origin; *analogue* denotes functional similarity only. Thus the arm of a man and the wing of a bird are homologous, but not analogous structures.

* Branchial arches (gill arches) in the developing human embryo suggest a biologic relationship with fishes, in which they are retained, and with higher vertebrates, in which they are suppressed, as they are in man.

The Cell.—The body grows from a single structure called a cell.[1] Segmentation, differentiation,† and specialization of the cell ultimately give rise to the complex structure of the human adult. In the developed body the cells have become so highly differentiated and specialized that they vary greatly in size, form, chemical composition, and function. Before these changes occur all the cells of the embryonic body appear very much alike and receive the name *embryonal cells*. In this stage they resemble

* In zoölogy the head end of the animal is called the anterior; the opposite end, posterior; the under surface, ventral, and the back, dorsal. With the erect position, as in man, the terms "anterior" and "ventral" serve identical purposes, for now the ventral part of the body goes forward. To designate the head end of man the term "cephalad" is sometimes used, and for the opposite end the term "caudad" is at times employed. The adjectives "caudal" and "cephalic" are at times appropriate.

† The terms "differentiation" and "specialization" are frequently used in biology, and are employed here to describe the processes that go on in the modification of cell structure and its adaptation to special function. By differentiation of cells the student is to understand that the cells have become different, that they appear changed in form and structure when viewed under the microscope. By specialization of cells the student is to understand that the differentiation has resulted in new or changed function. In a precise manner of speaking there is probably no differentiation without specialization, and vice versa. Whether structure makes function or function forms structure is not determined by this usage. The biologic world is not in agreement on this point. In the embryo function is at a minimum and yet structure increases rapidly; on the other hand, after birth function frequently determines structure.[2]

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simple unicellular organisms, such as the ameba (Fig. 2), which illustrates many of the characteristics of this early cell formation.

A diagram of such a cell (Fig. 3) shows an organized mass called *protoplasm* which is seen to be made up of other constituent parts. The conspicuous portion of the cell is the *cytoplasm* or body of the cell. This appears as a reticular, granular, or homogeneous material according to the state of its activity. The cytoplasm is constantly changing; the life processes of the cell, reflecting simple and complex chemical combinations within the cell, account for a wide variation in structural composition at

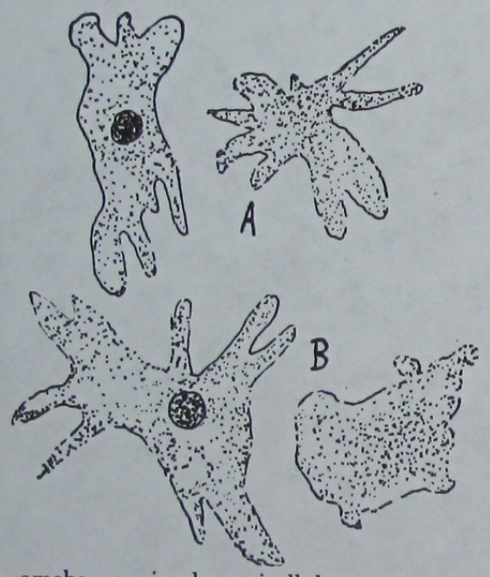

Fig. 2.—An ameba, a simple unicellular organism: *A*, An ameba divided into a nucleated and non-nucleated portion; *B*, the same portion after an interval of eight days. (After Hofer.)

different times. The *limiting membrane* is usually well marked. In some highly specialized cells (cardiac muscle) the cytoplasm of one cell will be continuous with that of an adjoining cell due to the absence of limiting membrane in certain areas. The *nucleus* is a small body within the cytoplasm. It contains small, irregular masses that stain deeply, called *chromatin*. The nucleus is considered the vital part of a cell because a mass of cytoplasm deprived of its nucleus soon loses its functional power and disintegrates (see Fig. 2). The *nucleolus* appears as a small spheric body within the nucleus. In the cytoplasm is observed a minute body, the

centrosome, vitally concerned in the phenomena of cell division. It is frequently surrounded by a clear zone, the *attraction sphere*, within which it appears as a minute speck, at times being double.

Functions of Living Cells.—A single cell to live must be able to carry on all the processes necessary for life.[2] Thus it must be able to take in and digest food and remove its waste; it must supply itself with oxygen to oxidize* the food that has been

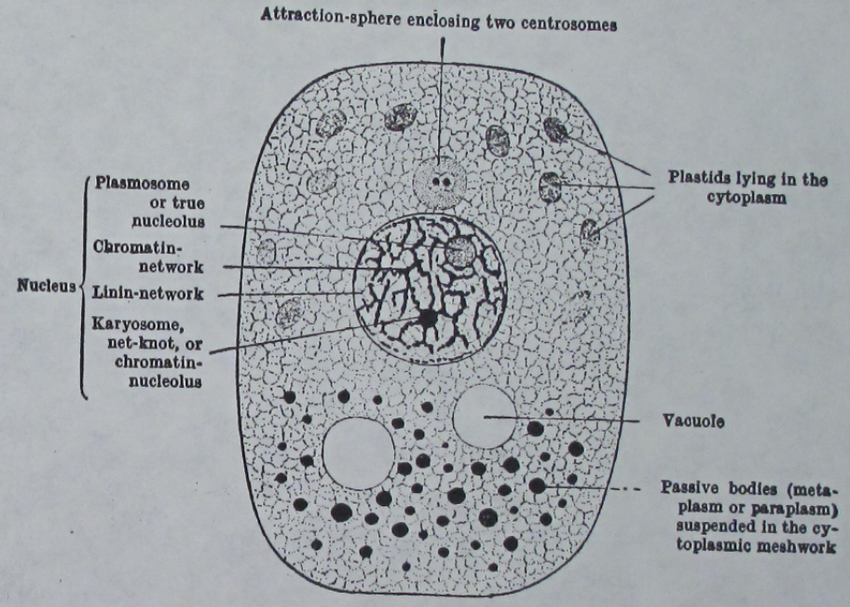

Fig. 3.—Diagram of a cell (Wilson).

assimilated. It must respond to stimuli in the environment around it, showing a sensitiveness to stimuli that indicates not

* *Oxidation* is the union of oxygen with some other substance, with the production of heat in the process. Unless the oxidation is very rapid the heat may not be perceptible. Most of the oxidations in the body go on very slowly, sufficient heat being produced to keep the temperature of the body at 98.6° F. In conditions of fever with disturbance of the heat-regulating apparatus of the body the oxidation may be more rapid, with resulting increase in temperature.

This oxidation of materials in the cell produces energy according to the characteristics of the cell, one yielding motion, another a secretion, another something else. This activity must be compensated for by a replacement of the materials used up. Hence substances are taken into the cell to restore the used material, and waste must be removed. This dual process is called *metabolism*.